Preliminary Study on Microbial Desulfurization: Targeting for H2S Removal in Biogas in by Bio-scrubber in Biogas Power Plant

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Bio-desulfurization generally oxidizes sulfide to elemental sulfur in aerobically oxidized by sulfide oxidizing microbes that should be extracted from biogas like biogas power plant which is establish in the area palm oil industry. The source of microbes was screened from various sources like in waste of coal, active sludge of mixing Palm Oil Mill Effluent (POME) – cow manure and spring water. Screening for the potential microbes were conducted by using synthetic chemical reagent as S source. Decomposition of chemicals as S sources, like NaHS or Na2S2O3, has been observed through microbial process where S is separated into elemental Sulphur (S_0). The screening firstly conducted in selective media for certain species like *Thiobacillus sp*. and continues with the addition of an S source to see if the microbes are able to decipher the S to sulfuric acid or S0. However, preference microbe that would be chosen to be applied in bio-scrubber was that capable to decompose the S source into S_0.

containing Sulphur separation was done in specific medium containing fertilizer as N source and potatoes dextrose broth as C source. The specific medium was added in artificial solution containing the active sludge to simulate desulfurization. At the starting fermentation, the pH was set between 5 and 6 and monitored daily. Sulphur was detected by the appearance of yellowish sediment at medium, predicted as elemental sulphur. The yellowish was strongly shown by dilution it in toluene. In addition, pH monitoring showed stable during sulfur separation. Further treatment of yellowish sediment has potential to produce by product by separation and purification the elemental Sulphur. Sulfide oxidizing microbes that includes filamentous sulfur microbe, photosynthetic sulfur bacteria and colorless sulfur bacteria, among which some species of the best group can oxidize sulfide to extracellular sulfur, and are the main culture of sulfide oxidation stage. This treated active sludge would be applied at biogas production from POME, especially in CSTR because 1200 ppm H2S containing in biogas cause corrosive to the reactor.

Keywords: desulfurization, H2S removal, biogas, bioscrubber, elemental Sulphur

BACKGROUND

Utilization of POME to produce biogas is conducted due to prevent the release of CH4 directly into the atmosphere which impacts 28 times more dangerous than CO2 as green house gas and significantly cause global warming[1)]. Moreover, the biogas also contains H2S that consider as corrosive gas. BPPT has been built up a biogas power plant in Terantam, PLTBg Terantam, using Palm Oil Mill Effluent (POME) as the feedstock. The anaerobic digestion, with cover lagoon system, converts biologically the organic compound in mesophilic. The biogas that produced containing roughly 57,6-% CH_4, 32,5%-mol CO_2, 1600 ppm H_2S, and others. Unfortunately, the H_2S compound in biogas engine will cause stinky and combusted to SO2, corrosive (Pokorna-

Krayzelova dkk., 2015). Therefore, H2S should be kept at level less than 200 ppm in order to maintain biogas engine from any potential damage[2]. In addition, H2S has lower calorie value than CH4 and decreasing combustion efficiency.

H2S removal from biogas can be done by various several methods. The most applicable at power plant scale is by scrubber, bio scrubbers, chemical scrubbers, and water scrubbers. Bio scrubbers works based on the performance of sulfur oxidizing microorganisms like Thiobacillus sp. to oxidize H2S to sulfate, thiosulfate, and / or elemental sulfur. In chemical scrubbers works based the chemical reaction. NaOH can be used due to ionic reaction with H2S and producing sulfate acid. Water scrubber works the compound characteristic on how much H2S can be dissolve in water. To enrich and accelerate the amount of H2S in water, utilizes pressurized water can be used to absorb H2S (Rahayu dkk., 2015).

H2S can be oxidized with FeSO4 and microbial process subsequently[3] but only applicable for biogas with H2S more than 10.000 ppm. Another researcher was also developed H2S removal from biogas with high aeration approximately 5% O2 in biogas[4]. Based on the property's biogas produced in the field containing up to 60% means flammable, this work would like to isolate any strain that work at minimum O2 and make the upper limit by 2% O2 to avoid explosion.

At bio-scrubber system on PLTBg Terantam, biogas will be flown towards the top of the Bio-Scrubber with pressures up to 50 mbarg. The modified liquid medium of cover lagoon effluent is also flown concurrently. The bio-scrubber system is also equipped by packing media that will pass through the pipe located at the bottom of the Bio-Scrubber. Biogas that has passed through The system is equipped with media packing which also serves to increase the contact surface area between biogas and liquid media. The contact of liquid medium and biogas will absorb most of H2S into liquid medium rather than CO2. Bio-scrubber does not only work based on the absorbtion but also microbial process where as the consortium microbes would consume the Sulphur compound and produce it as elemental Sulphur or sulfuric acid.

The processing that emphasizes on the ability of microbes to decompose molecules containing Sulfur contained in biogas, especially S_0, is the target of this study, because the sulfur can be separated from liquid media. Therefore, it needs to be done to screen the potential microbes or consortium microbes that applicable for bio-scrubber at biogas power plant.

This problem of byproduct of biogas such as H2S will be solved. Moreover, Indonesia as rainy-tropical country has high diversity microorganism. Screening any microbes that capable to decrease H2S from biogas by local microorganism is a challenge. The use of microorganisms for H2S separation of biogas. In this context, microbes with the corresponding release of H2S from biogas and convert it to elemental Sulphur or other sulfuric molecules.

METHODOLOGY

Screening culture of Sulphur or chemoautotrophic Sulphur oxidizing microbes were conducted from several environment: landfill around coal, outlet POME of biodigester, manure, and micro algae. The microbial screening was done by growing microbes from those sources in growing media of modified PDB (39 gr in 1 litre) that added by some nutrients (CaPO4, NH4Cl, etc)[5] and S sources such as Na2S2O3[6]. The microbial growth was carried out at room temperature

and monitored were pre-grown at 30°C with shaking water bath incubator up to 2 weeks. During this fermentation, the pH was observed. Afterward, total S was measured at the end of fermentation.

Sulfida analysis.

Sample, 1 mL, was filtered through 0.2 micron filter to separate the cell and put into falcon tube. And added by 1 mL Zn(CH3COO)2 1 M, 1 mL NaOH 6 N, and aquadest so that the total volume reached aliquot, 15 mL. The aliquot was centrifuged to separate the deposit such as ZnS and other compounds. The deposit was washed by aquadest in the same volume to solve the impurities. Deposit of ZnS was separated and put into Erlenmeyer and added by 50 ml aquadest. The sample in the Erlenmeyer was added by Iodine solution 0.025 N excessively. ZnS was dissolved by HCl so that become yellowish. Final preparation was conducted by put in starch so that the sample would change to blackish blue. Finally, the sample was titrated by Sodium Thisulphate 0.025 N until the solution colour fade out.

S ppm = $S\ ppm = \frac{[AB-CD]*16.000}{V_{sample\ ml}}$ … (1)

A : Iodine volume, ml

B : Normalitas iodine

C : Sodium thiosulphate volume, ml

D : normalitas of sodium thiosulphate

Sulfuric Acid analysis.

Sulfuric acid analysis, H2SO4, is analyzed based on deposit formation of $BaSO4^7$ by reacting H2SO4 and BaCl2. The analysis was done in buffer solution: 30 g MgCl2·6H2O, 5 g Na(CH3COO)·2H2O, 1KNO3 and 20 mL CH3COOH 99% in 1000 mL water.

The buffer is used to analyze some known sulfuric solutions. The sulfuric solution was made by Na2SO4 anhydrate. The concentration was measured with spectrophotometry λ = 420 nm. The result is used to make standard curve. Finally, any experimental sample is analyze using the buffer in the same way with standard sample and calculate using standard curve.

RESULT AND DISCUSSION

Following the qualitative analysis of degraded Sulphur from its molecules and the growth of sulfur oxidizing microbes. Broadly speaking, the results of this basic research can be seen from the following points:

1. changes in pH which indicate acid formation which is most likely directly and indirectly due to the influence of derivative products from sulfur content.

2. The yellow sediment which is predicted is the result of decomposition of sulfur content into elemental sulfur.

3. Decrease the total S level from the initial condition.

CONCLUSIONS

This basic research results in a decrease in sulfur content in the simulation media. This shows that we have indigenous microbes in Indonesia that have the potential to be applied to bio-scrubber to purify H2S in biogas power plant which is currently being promoted in Indonesia.

The purification of H_2S is a must because the requirement of biogas engine. The wild type strain is very important for the effectiveness of bio-scrubber to reduce H2S at level at most 200 ppm. Direct using biogas on the generator will result in the engine being quickly damaged due to corrosion, both inside the engine generator and the outside. This H2S purification will automatically reduce CO2 levels related to the solubility of CO2 in water. Furthermore, CH4 concentration will automatically increase due to reduction of both CO2 and H2S.

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